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FACTORS AFFECTING THE PRICE OF WATERMELONS AT LOS ANGELES

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THE PROBLEM

As the quantity of any commodity put on the market increases, the value which the consumer places on each unit declines, and hence he will pay less for each unit. It is the purpose of this study to determine for a specific commodity at a specific market (watermelons on the Los Angeles market) how much prices have actually changed during the past six years with the various changes in the supply, and to measure the effect of all other factors on which data are available and which affect the price.

It is a matter of general experience that variations in the supply of one commodity may cause large proportional changes in its price, whereas similar variations in the supply of another commodity may cause only small proportional changes in its price. For example, an increase of 20 per cent in the supply of potatoes would cause a large relative decrease in their price.[(8)] A similar increase in the supply of apples would cause a much smaller proportional decrease in their price.[(5)] It is possible also that the demand for a commodity may change over a period of time. The price of potatoes seems to change more now for a given change in the supply than it did twenty years ago.[(1)] Changes of this kind however, usually come about gradually and the trend can be noted before a marked change occurs.

The time unit used in measuring the effect of the various factors affecting price has varied with the nature of the commodity. With annual crops which can be stored for a year or more, the year has

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been the usual unit of time used. Thus in the study of oat prices[4] the total production in the United States in one year plus carry-over was taken as the supply, and the price used was the average price at Chicago for the crop year. The study of potato prices[8] was based on the average price at St. Paul from September to May inclusive, and the supply was the production of the twenty-seven late potato states. As more complete and accurate data become available over a longer time on shipments, storage, and movements into consumption, it may become possible to estimate future prices more accurately for specific periods within the year. Haas and Ezekiel's study of hog prices[2] was based on the month as the unit of time. Hedden[3] in his study of watermelon prices used the day as the unit.

In the study of watermelon prices at Los Angeles it seemed advisable, because of conditions which are described in the following two paragraphs, to take the week as the unit of time.

Most commodities pass through several hands in going from producer to consumer. The price the consumer can be induced to pay for the commodity sets the final limit which any middleman can pay in the long run. Since some time must elapse between the time a commodity is sold to the jobber and the time it is finally sold to the consumer, the middleman must continually make estimates of the prices which the consumers will be willing to pay for a given supply, in order to decide on the price which he (the middleman) can pay and still maintain a necessary margin.

It is evident that the estimates of the middleman will not always be correct, and besides, the producer or shipper also is a party in the bargaining and does what he can to get a favorable return for himself. The price paid for any one lot of watermelons, or the representative price for a day, is probably seldom correctly proportioned to the price which the consumer is willing to pay for the quantity available on that day. The representative price for a week is more likely to be in correct proportion to the price which the consumer is willing to pay.

DATA AVAILABLE

The daily market reports of the U. S. Bureau of Agricultural Economics are available for the Los Angeles market since 1922. These give the daily arrivals, cars on track, and prices of the important fruits and vegetables. Weekly averages of the data on watermelons, cantaloupes, and all other fruits given consistently for the six-year period are shown in table 1. Data on average maximum

temperature lagged three days are also shown. It is often assumed that cantaloupes and other fruits affect the watermelon prices to some extent. These assumptions have been tested mathematically and the results are shown in the following pages.

ANALYSIS OF DATA

The correlation between the supply of watermelons, as measured by the carlots on track (B) and the price (X), has been discussed in Bulletin 449[6] of this station. The gross or simple correlation between these two factors is —0.8455, which indicates that approximately 71 per cent of the variations in watermelon prices can be accounted for by variations in the supply, leaving 29 per cent to be accounted for by other factors.

Carlot arrivals of watermelons (A) also are fairly closely correlated with prices (X), the gross correlation index being —0.6604 (see table 2). The net effect of arrivals on prices, however, is not so marked, since carlot arrivals and cars on track are closely associated, as shown by the correlation coefficient of + 0.7405.

One would logically expect the temperature (C) to be positively correlated with watermelon prices, since the demand for watermelons is increased as the temperature goes up. The gross correlation of average maximum daily temperature (lagged 3 days) and of watermelon prices for the weekly periods shown in table 1 is —0.0583. The negative correlation is due to the fact that temperatures usually go up toward the end of the season while prices decline. When corrections are made for the normal seasonal decline in the price of watermelons, the net effect of a rise in temperature is to raise the price slightly.

Corrections are frequently made for seasonal variations in prices of watermelons first, and the corrected, or adjusted, prices then correlated with the other factors affecting prices. In this study indexes of seasonal variations were calculated and included in the multiple-correlation analysis with the four other factors mentioned above. The index for each week was calculated by taking the arithmetic mean of the average price of the week for each of the six years covered in this investigation.

The gross correlation of the seasonal indexes of prices (D) and the price (X) is + 0.5600. The multiple correlation of these four factors with price (X) was calculated; this gave a multiple-correlation index of 0.861. The residuals obtained from estimates based on the

TABLE 1

RELATION OF LOS ANGELES PRICES FOR WATERMELONS TO WATERMELON CARLOT ARRIVALS AND CARLOTS ON TRACK, TEMPERATURE, SEASONAL INDEX OF PRICES, CANTALOUPE CARLOT ARRIVALS AND CARLOTS ON TRACK, AND IMPORTANT FRUIT CARLOT ARRIVALS AND CARLOTS ON TRACK, 1922–1927

Number of period	Date, period ending	Watermelons Average number of carlots each day		Maximum temperature in degrees Fahrenheit (3-day lag)	Watermelons			Cantaloupes Average number of carlots each day		Important Fruits Average number of carlots each day	
		Arrivals	On track		Seasonal index of prices	Actual price, cents per pound	Estimated price, cents per pound	Arrivals	On track	Arrivals	On track
		A	B	C	D	X	$\overline{X}$	E	F	G	H
	1922										
1	June 21	6	7	80	276	4.01	3.43	18	5	1.7	0
2	28	26	14	86	223	3.05	3.09	37	17	5.5	4.4
3	July 5	52	54	77	161	1.94	1.80	61	62	4.5	6.0
4	12	45	57	77	139	1.35	1.76	26	51	4.3	2.4
5	19	22	42	81	150	1.59	2.36	14	23	1.4	1.6
6	26	39	45	79	137	1.79	1.74	6	13	12.6	2.6
7	Aug. 2	13	35	80	159	1.75	2.15	9	11	10.6	10.4
8	9	16	10	80	167	2.06	2.58	3	8	6.8	10.0
	1923										
9	June 14	8	8	71	276	3.19	2.77	13	16	2.2	12.0
10	21	28	87	71	223	2.05	1.65	16	24	2.4	5.8
11	28	32	97	70	161	1.63	1.33	24	39	5.4	10.6
12	July 5	43	137	80	139	1.62	1.29	29	35	4.4	7.6
13	12	27	98	75	150	1.64	1.54	12	29	2.6	5.2
14	19	31	83	76	137	2.04	1.53	5	14	6.6	12.0
15	26	20	51	82	159	2.81	2.00	2	3	11.8	28.6
16	Aug. 2	13	44	83	167	2.89	2.22	3	3	10.8	27.6
	1924										
17	June 14	12	22	73	276	2.70	2.71	18	25	1.4	2.8
18	21	21	37	81	223	3.00	2.98	37	52	5.0	6.8
19	28	28	45	76	161	2.23	1.96	21	45	5.4	11.2
20	July 5	35	56	83	139	1.81	2.09	27	74	4.2	4.2
21	12	38	116	78	150	1.83	1.41	13	26	4.6	4.6
22	19	43	109	79	137	1.66	1.41	17	43	5.8	13.4
23	26	27	125	75	159	1.18	1.23	2	10	9.6	12.8
24	Aug. 2	32	65	82	167	1.17	1.60	1	2	20.0	32.2

	1925										
25	June 7	9	26	68	276	2.66	2.42	25	32	1.0	1.4
26	14	24	34	74	223	2.21	2.19	26	33	5.4	6.0
27	21	22	72	73	161	1.51	1.53	24	35	10.0	14.6
28	28	36	63	80	139	1.51	1.69	15	24	9.8	12.6
29	July 5	64	107	84	150	2.03	1.51	35	53	5.8	2.8
30	12	48	131	76	137	1.01	0.94	15	44	19.6	13.6
31	19	36	105	88	159	2.04	1.65	6	14	13.0	16.6
32	26	29	66	83	167	1.92	1.57	7	7	22.4	15.8
	1926										
33	June 7	27	37	76	276	1.97	2.38	25	27	6.2	7.8
34	14	41	92	71	223	1.12	1.38	20	29	9.8	16.0
35	21	47	171	73	161	0.82	0.82	13	19	14.6	25.4
36	28	52	168	76	139	0.76	0.93	7	11	9.0	19.4
37	July 5	63	182	82	150	0.80	0.96	3	11	9.4	12.0
38	12	47	144	75	137	0.66	0.87	1	3	19.8	25.4
39	19	35	177	78	159	0.72	0.76	2	1	26.6	40.6
40	26	53	155	84	167	1.03	0.75	2	2	39.2	60.4
	1927										
41	June 14	10	20	71	276	2.05	2.69	35	26	0	0
42	21	17	39	74	223	1.94	2.23	32	37	4.0	5.6
43	28	32	63	77	161	1.54	1.63	41	50	12.0	24.0
44	July 5	43	132	77	139	1.27	1.17	39	67	8.4	20.4
45	12	39	141	86	150	1.09	1.46	34	41	5.4	16.2
46	19	31	142	80	137	1.07	1.08	18	49	16.4	18.6
47	26	44	144	88	159	1.02	1.22	7	15	18.8	27.6
48	Aug. 2	29	137	84	167	0.94	1.11	6	5	24.8	53.8

Columns A, B, X, E, F, G, and H compiled from Harris, Homer A. Market News Service U. S. Bur. Agr. Econ. Daily Market Reports, Los Angeles, Calif., current issues.

Column C compiled from U. S. Weather Bureau Climatological Data—California Section, current issues.

Carlot arrivals represent arrivals since 7:00 a.m. of previous day.

Carlots on track represent morning's count at 7:00 a.m. and includes new arrivals as well as cars partly unloaded.

Prices based on actual prices obtained between 7:00 and 9:00 a.m. by Los Angeles receivers and wholesalers from their sales to jobbers. Where prices were quoted in dollars per carlot, they were converted to cents per pound on the basis of 12 tons to each carlot.

Column $\overline{X}$ estimated prices based on the regression equation: $\log \overline{X} = -0.3558 - 0.00136A - 0.00206B + 0.00939C + 0.00063D - 0.00686G$.

Important fruits include apricots, peaches, pears, plums and miscellaneous melons.

multiple regression equation including the four independent factors above, A, B, C, and D, were then correlated with cantaloupe carlot arrivals (E), carlots of cantaloupes on track (F), and carlot arrivals of important fruits (G). The residuals gave a correlation index of -0.37 with factor G, which indicated that arrivals of important fruits had an independent effect on watermelon prices of sufficient importance to include with the other four independent factors. The gross correlation with price was -0.5973. The multiple-correlation index was raised from 0.8610 to 0.8896 by including the effect of arrivals of important fruits (G) with factors A, B, C, and D.

Actual and Estimated Prices for Watermelons on the Los Angeles Market, 1922–1927

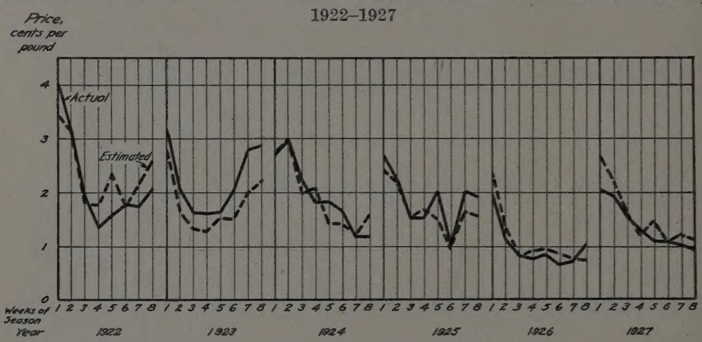

Fig. 1. The estimated prices are based on the average net relationship that prevailed during the entire period, between actual prices and carlot arrivals of watermelons, carlots of watermelons on track, maximum temperature, time of the season, and carlot arrivals of important fruits.
(Data from table 1.)

Having obtained all of the gross correlations between the various factors described in the preceding pages they can be used in obtaining, first the partial regression coefficients, second the coefficients of determination, third the multiple-correlation index, and fourth the regression equation. The method followed is described in detail by Wallace and Snedecor.[7]

Multiple Correlation Index and Regression Equation

The combined effect of the first five factors, carlot arrivals A, carlots on track B, temperature C, the seasonal index D, and carlot arrivals of important fruits G, on the price of watermelons X at Los Angeles is shown by the multiple correlation index $^{P}\log X.ABCDG$,

which is equal to 0.8896. This takes into account all of the intercorrelations between the independent factors. A correlation index of 0.8896 indicates that approximately 79 per cent of the variations in price can be ascribed to the variations in the five factors mentioned above. The net regression equation obtained by the method described by Wallace and Snedecor[(8)2] is as follows:

$$\log \overline{X} = -0.3558 - 0.00136A - 0.00206B + 0.00939C + 0.00063D - 0.00686G$$

On the basis of this equation, which expresses the average net relationship of each of the factors A, B, C, D, and G, and prices (X), the estimated prices in column $\overline{X}$, table 1, were obtained. Approximately one-half of the estimated prices for the past six years based on this equation come within 15 per cent of the actual prices. A comparison of the actual and estimated prices is also shown in figure 1. It will be noted that after the third week in 1922 the actual prices were below the estimated, except in the sixth week, while during 1923 all of the actual prices were above the estimated. Again in 1926 the actual prices were generally below the estimated. Deviations of actual prices from estimated prices were probably due to the following factors:

1. The quality of the watermelons may have been below the average in 1922 and 1926 and above the average in 1923, but no statistical measure of quality for this period exists.

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2 The first step consists in obtaining the partial regression coefficients $\beta \log XA$, $\beta \log XB$, $\beta \log XC$ $\beta \log XD$ and $\beta \log XG$, by solving the following:

$$\beta \log XA + {}^{r}AB\beta \log XB + {}^{r}AC\beta \log XC + {}^{r}AD\beta \log XD + {}^{r}AG\beta \log XG = {}^{r}A \log X$$
$${}^{r}AB\beta \log XA + \beta \log XB + {}^{r}BC\beta \log XC + {}^{r}BD\beta \log XD + {}^{r}BG\beta \log XG = {}^{r}B \log X$$
$${}^{r}AC\beta \log XA + {}^{r}BC\beta \log XB + \beta \log XC + {}^{r}CD\beta \log XD + {}^{r}CG\beta \log XG = {}^{r}C \log X$$
$${}^{r}AD\beta \log XA + {}^{r}BD\beta \log XB + {}^{r}CD\beta \log XC + \beta \log XD + {}^{r}DG\beta \log XG = {}^{r}D \log X$$
$${}^{r}AG\beta \log XA + {}^{r}BG\beta \log XB + {}^{r}CG\beta \log XC + {}^{r}DG\beta \log XD + \beta \log XG = {}^{r}G \log X$$

The solution of these equations gave the following values:

$$\beta \log XA = -0.1034$$
$$\beta \log XB = -0.5671$$
$$\beta \log XC = +0.2465$$
$$\beta \log XD = +0.1546$$
$$\beta \log XG = -0.2868$$

These values, the means, and standard deviations were substituted in the general equation:

$$\log \overline{X} = M_x + \beta \log XA \,.\, \frac{\sigma \log X}{\sigma A}(A - M_A) + \beta \log XB \,.\, \frac{\sigma \log X}{\sigma B}(B - M_B)$$
$$+ \beta \log XC \,.\, \frac{\sigma \log X}{\sigma C}(C - M_C) + \beta \log XD \,.\, \frac{\sigma \log X}{\sigma D}(D - M_D)$$
$$+ \beta \log XG \,.\, \frac{\sigma \log X}{\sigma G}(G - M_G)$$

Substituting the values in the above gives:

$$\log \overline{X} = 0.2089 + \left(-0.1034 \times \frac{0.18397}{14.01852}\right)(A - 31.9792)$$
$$+ \left(-0.5671 \times \frac{0.18397}{50.6040}\right)(B - 83.1666) + \left(0.2465 \times \frac{0.18397}{4.82895}\right)(C - 78.1875)$$
$$+ \left(0.1546 \times \frac{0.18397}{45.2296}\right)(D - 176.50) + \left(-0.2868 \times \frac{0.18397}{7.6958}\right)(G - 9.6042)$$

This reduces to

$$\log \overline{X} = -0.3558 - 0.00136A - 0.00206B + 0.00939C + 0.00063D - 0.00686G$$

2. The fluctuations of actual prices above and below the estimated in 1924 and 1925 suggest the possibility of alternating periods of over and under estimates lasting one or two weeks, in which the dealers misjudged the consumers' demand.

3. Some of the factors that have affected watermelon prices may have been only of a temporary nature which would be impossible to measure accurately.

4. It is difficult to express in one figure a representative price for sales of one day or week, hence the actual prices shown in table 1 may contain errors.

5. The increase in shipments by truck in recent years has made the data on supply somewhat inaccurate.

6. The general price level from 1922 to 1927, according to the Bureau of Labor Statistics index number of all commodities varied from 163 in July, 1925 to 147 in July, 1927. This variation might be expected to account for some of the residuals in prices, but the correlation between the index numbers and residuals of prices was insignificant. Possibly the Bureau of Labor Statistics index number does not represent accurately changes in the price level at Los Angeles.

The above factors undoubtedly explain most of the deviations of actual from estimated prices. Other factors and limitations in the statistical methods must account for the remaining residuals.

Correlation of Other Factors with Watermelon Prices

Table 2 also shows the gross correlations of cantaloupe arrivals (E) and carlots of cantaloupes on track (F), and carlots of important fruits on track (H) with watermelon prices. It seems reasonable to expect that large supplies of cantaloupes or other fruits would tend to depress watermelon prices. However, the gross correlation index between carlot arrivals of cantaloupes and watermelon prices is $+0.3083$ which indicates that for the 48 weeks shown in table 1 there has been a slight tendency for the opposite relationship to prevail.

The explanation for this contradiction between what one might expect and what one finds lies in the differences in the seasonal movement of cantaloupes and watermelons. Cantaloupe arrivals are often at their peak about the second or third week of the watermelon season, whereas watermelon arrivals usually reach their peak in the fourth, fifth, or sixth weeks. From that time on there is usually a decline in arrivals which often occurs at the same time as the seasonal decline

in watermelon prices. When the effect of the first four factors A, B, C, and D (table 1) on prices was taken into account, and the residuals of prices (the differences between the logarithms of actual and estimated prices) correlated with carlot arrivals of cantaloupes, the correlation index became + 0.1606, which is of no practical significance so far as showing an independent effect on watermelon prices is concerned.

TABLE 2

GROSS CORRELATIONS OF WATERMELON PRICES AND EIGHT FACTORS, AND INTERCORRELATIONS OF A, B, C, D, AND G

Factors correlated	Watermelons		Temper-ature	Seasonal index of prices	Cantaloupes		Important fruits	
	Carlot arrivals	Carlots on track			Carlot arrivals	Carlots on track	Carlot arrivals	Carlots on track
	A	*B*	*C*	*D*	*E*	*F*	*G*	*H*
log X (Watermelon prices)	−0.6604	−0.8455	−0.0583	+0.5600	0.3038	0.1063	−0.5973	−0.5383
A	....	0.7405	0.2718	−0.6310	....	....	0.3713	....
B	....	....	0.1824	−0.5865	....	....	0.5443	....
C	....	....	....	−0.4075	....	....	0.3845	....
D	....	....	....	....	....	....	−0.3769	....

The carlots of important fruits on track (H) gives a gross correlation index of — 0.5383 with prices, but when the effect of factors A, B, C, D, and G is taken account of the correlation with the price residuals becomes + 0.0349.

The efforts to improve the accuracy of the watermelon price estimates by including factors E, F, and H (tables 1 and 2) proved fruitless. The most accurate method discovered so far is on the basis of the five factors A, B, C, D, and G.

IMPORTANCE OF THE INDIVIDUAL FACTORS

The coefficients of determination[3] give at least a rough measure of the relative importance of the different factors affecting prices. Expressed in percentages they are as follows:

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[3] The coefficient of determination is the product of the partial regression coefficient (see footnote 2, p. 311) and the corresponding gross correlation index shown in table 2. The sum of the coefficients of determination equals the square of the multiple correlation index.

$$\text{Thus } P^2=\beta \log XA \,.\, {}^{r}A \log X+\beta \log XB \,.\, {}^{r}B \log X+\beta \log XC \,.\, {}^{r}C \log X+\beta \log XD \,.\, {}^{r}D \log X +\beta \log XG \,.\, {}^{r}G \log X$$

Substituting

$$P^2=(-0.1034\times-0.6604)+(-0.5671\times-0.8455)+(+0.2465\times-0.0583)+(0.1546\times+0.5600)+(-0.2868\times-0.5973)=+0.0683+0.4795-0.0144+0.0866+0.1713=+0.7913$$

$$P=\sqrt{0.7913}=0.8896$$

A—Average daily carlot arrivals of watermelons	+ 6.83 per cent
B—Average carlots of watermelons on track	+ 47.95 " "
C—Average of maximum temperatures (3-day lag)	— 1.44 " "
D—Seasonal variation in price	+ 8.66 " "
G—Average daily carlot arrivals of important fruits	+ 17.13 " "
Total	79.13

The algebraic sum of the coefficients of determination is 79.13, which indicates that approximately 79 per cent of the variation in prices are accounted for by the variation in these five factors. The negative coefficient of determination for temperature shows that its effect is in the opposite direction from that of the other factors. The most important factor affecting prices is the number of carlots of watermelons on track. Next in importance is the carlot arrivals of important fruits, third, the seasonal factor, and fourth, the carlot arrivals of watermelons.

The square root of the sum of the coefficients of determination gives the multiple correlation index $P_{\log X.ABCDG} = 0.8896$.

TABLE 3

AVERAGE NET EFFECT OF CARLOT ARRIVALS OF WATERMELONS (A) ON PRICE (X)

Carlot arrivals	Price* in cents per pound
A	X
0	1.79
10	1.73
20	1.68
30	1.63
40	1.58
50	1.53
60	1.48
70	1.44

* Based on the regression equation $Log\ \overline{X} = 0.25238 - 0.00136A$.

EFFECT OF THE INDIVIDUAL FACTORS ON WATERMELON PRICES

Carlot Arrivals of Watermelons.—The regression equation showing the average net effects of the carlot arrivals (A), carlots on track (B), temperature (C), seasonal indexes (D), and carlot arrivals of important fruits (G), on price (X) is as follows:

$$\log \overline{X} = -0.3558 - 0.00136A - 0.00206B + 0.00939C + 00063D - 0.00686G$$

Now substituting the means of B, C, D, and G in this equation and varying A, the net effect of variations in A are obtained; these are

shown in table 3 and figure 2. When the number of carlots increased from ten to twenty, the price decreased on an average from 1.73 cents to 1.68 cents a pound, approximately 3 per cent. An increase in carlot arrivals from ten to seventy carlots decreased the price 17 per cent.

AVERAGE NET EFFECT OF CARLOT ARRIVALS OF WATERMELONS UPON PRICES

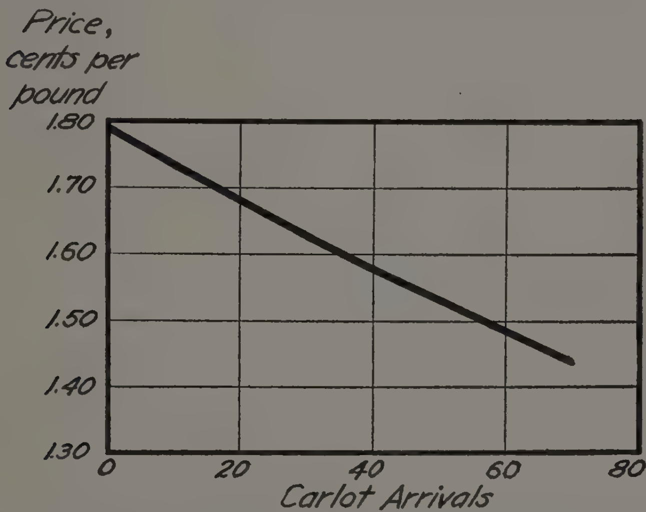

Fig. 2. The average net effect of each increase of 10 carlots was to decrease the price approximately 3 per cent. (Data from table 3.)

Carlots of Watermelons on Track.—The average net effect on price of carlots on track is obtained in the same way as for carlot arrivals. The results are shown in table 4 and figure 3. An increase from twenty carlots to forty carlots on track was accompanied (other factors being at an average) by a decrease in price from 2.18 cents to 1.99 cents or approximately 9.0 per cent.

Maximum Temperature.—The average net effect of maximum temperature, lagged three days, on watermelon prices is shown in table 5 and figure 4. An increase of four degrees Fahrenheit in temperature, other factors remaining at an average, resulted in an average increase of 9.0 per cent in price. Thus with the temperature at 68° Fahrenheit (see table 5), with other factors at an average, the price was 1.29 cents a pound. An increase in temperature to 72° Fahrenheit raised the price to 1.42 cents, approximately a 9.0 per cent increase.

AVERAGE NET EFFECT OF WATERMELON CARLOTS ON TRACK UPON PRICES

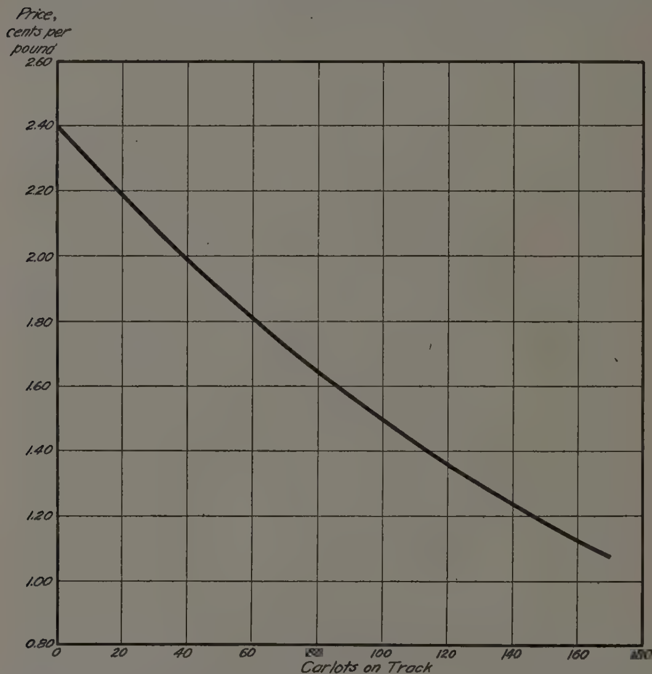

Fig. 3. Each increase of 10 carlots on track had the average net effect of reducing the price approximately 4.5 per cent. (Data from table 4.)

TABLE 4

AVERAGE NET EFFECT OF CARLOTS ON TRACK OF WATERMELONS (B) ON PRICE (X)

Carlots on track	Price* in cents per pound
B	X
0	2.40
20	2.18
40	1.99
60	1.81
80	1.64
100	1.49
120	1.36
140	1.24
170	1.07

* Based on the regression equation $Log\ \overline{X}=0.38021-0.00206B$.

AVERAGE NET EFFECT OF TEMPERATURE (LAGGED THREE DAYS) UPON WATERMELON PRICES

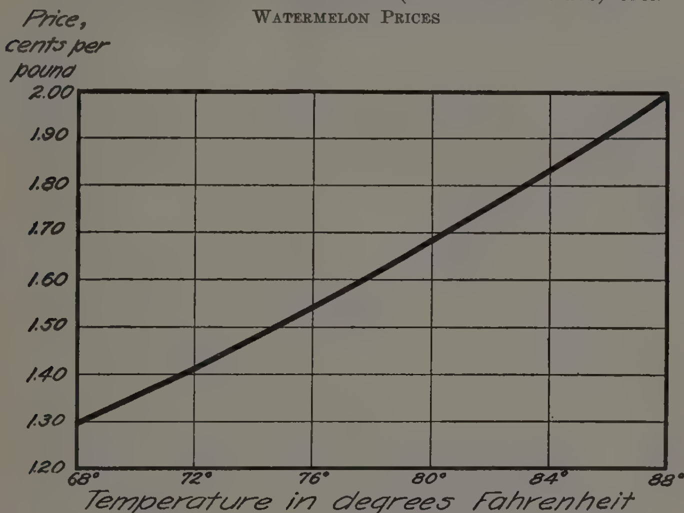

Fig. 4. With other factors held constant, the average net effect of an increase of four degrees Fahrenheit in temperature was to raise prices approximately 9.0 per cent. (Data from table 5.)

TABLE 5

AVERAGE NET EFFECT OF TEMPERATURE (LAGGED 3 DAYS) (C) ON PRICE OF WATERMELONS (X)

Temperature in degrees Fahrenheit	Price* in cents per pound
C	X
68	1.29
72	1.42
76	1.54
80	1.68
84	1.83
88	2.00

* Based on the regression equation $Log\ \bar{X} = -0.52529 + 0.00939C$.

Time of the Season.—The average net effect of the time of the season is shown in table 6 and figure 5. Holding the other factors at an average, the price of watermelons the second week averaged 1.73 cents a pound compared with 1.87 cents for the first week (see table 6 and figure 5). In other words the net effect of the advance of the watermelon season from the first to the second week was to lower the price 7.4 per cent. The low point of the season was reached in the sixth week, after which there was a slight recovery.

AVERAGE NET EFFECT OF TIME OF SEASON UPON WATERMELON PRICES

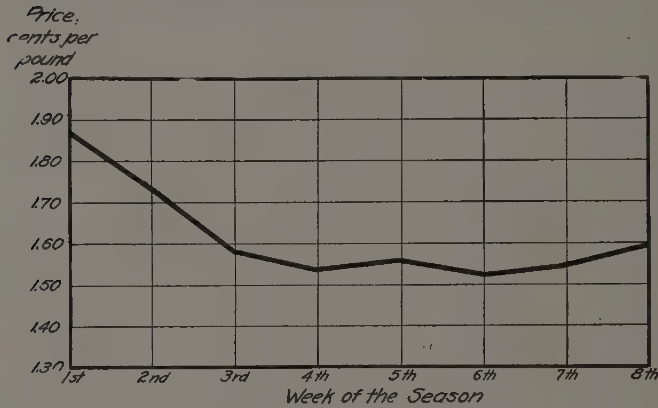

Fig. 5.—The average net effect of the time of the season on prices was to cause them to decline until after the fourth week. Some recovery occurred in the fifth, seventh, and eighth weeks.
(Data from table 6.)

TABLE 6

AVERAGE NET EFFECT OF SEASONAL INDEX (D) ON PRICE (X)

Week of season	Seasonal index	Price* in cents per pound
	D	X
1	276	1.87
2	223	1.73
3	161	1.58
4	139	1.53
5	150	1.56
6	137	1.53
7	159	1.55
8	167	1.60

* Based on the regression equation $Log\ \overline{X}=0.09769+0.00063D$.

Carlot Arrivals of Important Fruits.—Table 7 and figure 6 show the net effect of carlot arrivals of important fruits on watermelon prices. An increase in arrivals of ten carlots of the important fruits (apricots, peaches, pears, plums, and miscellaneous melons, the fruits for which records are available for each of the years 1922 to 1927) caused a decrease of 14.6 per cent in price. For example, the increase in arrivals from ten carlots to twenty carlots brought an average decrease in price from 1.61 to 1.37 cents a pound, or 14.6 per cent.

AVERAGE NET EFFECT OF CARLOT ARRIVALS OF IMPORTANT FRUITS UPON PRICES OF WATERMELONS

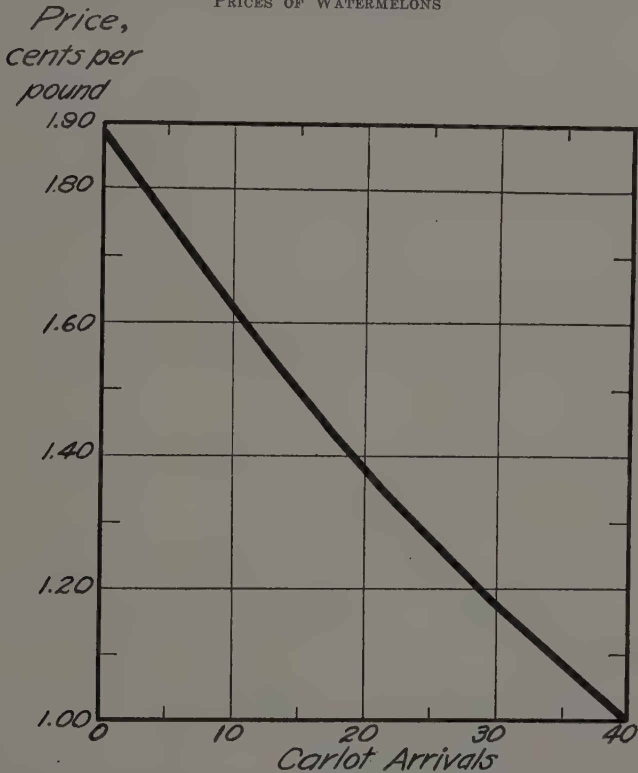

Fig. 6. An increase of 10 carlots in arrivals of important fruits (other factors remaining equal) brought an average decrease in price of 14.6 per cent. (Data from table 7.)

TABLE 7

AVERAGE NET EFFECT OF CARLOT ARRIVALS OF IMPORTANT FRUITS* (G) ON PRICE X

Carlot arrivals	Price† in cents per pound
G	X
0	1.88
5	1.74
10	1.61
20	1.37
30	1.17
40	1.00

* Important fruits include apricots, peaches, pears, miscellaneous melons, and plums.

† Based on the regression equation Log $\overline{X} = 0.27477 - 0.00686G$.

HOW TO USE THE RESULTS OF THESE STATISTICAL ANALYSES

Every buyer and seller must make estimates of the prices that will move a given supply of a commodity under a given set of conditions. A large part of the success of anyone engaged in buying and selling depends upon the accuracy of his estimates of the prices that will equate supply and demand. The only basis for making these estimates is past experience. The estimates may be based on some mental calculations of figures that left their impress on the mind, or it may be based on careful analysis of statistical data that have been kept over a long time plus any other knowledge of a non-statistical nature that every business man accumulates. In either case the assumption is made that the factors considered will continue to have the same effect on prices in the future that they have had in the past. If this did not generally hold true we would have no basis for estimating the future by any method.

The results obtained on factors affecting watermelon prices at Los Angeles should not be used without an understanding of their limitations and an appreciation of the need of an intimate knowledge of the business in addition to the quantitative relationships shown in the equation on pages 311 and 314. Estimating the most probable price on the basis of carlots on track has been explained in a previous bulletin.[6]

Estimating the most probable price on the basis of the factors used in the equation can be illustrated by estimating the price for a certain time in 1928 assuming a definite set of conditions. The price estimates shown in table 1 are based upon the relationship of average prices by weeks, and averages for the same weeks of the various factors affecting prices, except temperature, which is for periods three days earlier.

Hence in order to estimate, say on a Monday morning, the price for that week ending Friday, it would be necessary to first estimate the average daily arrivals of watermelons and important fruits and the carlots of watermelons on track for the rest of the week.

This would mean estimating prices on the basis of supply estimated so far ahead that most dealers would doubtless prefer to estimate the prices directly rather than in the round-about way. However, if receipts and cars on track were estimated two days in advance and an average worked out for the week ending on Wednesday morning, a very close adjustment could be made for expected changes in

arrivals and carlots on track for the next two days. The correlation with temperature is based on a three-day lag of temperature so that the average temperature up to Sunday would give data corresponding to the other data for the period ending the next Wednesday. The seasonal index of prices is selected according to the week of the season in which the period in question happens to fall.

Let us assume now that the Monday comes in the third week of the season, and that the various adjustments give the following values:

A—Average carlots arriving daily of watermelons for week ending on Wednesday .... = 32
B—Average carlots on track of watermelons each day for week ending on Wednesday .... = 63
C—Average maximum temperature for week ending on Sunday .... = 77
D—Seasonal index of price (third week) .... = 161
G—Average carlots of important fruits arriving daily for week ending on Wednesday .... = 12

Substituting these values in the equation

$$\log \overline{X} = -0.3558 - 0.00136A - 0.00206B + 0.00939C + 0.00063D - 0.00686G$$

gives

$$\begin{aligned}\log \overline{X} &= -0.3558 - 0.00136 \times 32 - 0.00206 \times 63 + 0.00939 \times 77 \\ &\quad + 0.00063 \times 161 - 0.00686 \times 12 \\ &= -0.3558 - 0.04352 - 0.12978 + 0.72303 + 0.10143 - 0.08232 \\ \log \overline{X} &= 0.21304\end{aligned}$$

Looking up the anti-log of 0.21304 we obtain $\overline{X} = 1.63$ cents—the estimated price per pound for that week. Estimates such as the above should be of value to shippers in deciding on the number of carlots that can be shipped to Los Angeles before losses are likely to be sustained, and to buyers and sellers in deciding on what price is justified on the basis of the conditions prevailing at a particular time.

SUMMARY

A statistical analysis of the factors affecting average weekly prices of watermelons at Los Angeles indicates that the most important factors, in the order named are: carlots of watermelons on track, carlot arrivals of important fruits, time of the season, carlot arrivals of watermelons, and maximum temperature lagged three days. Weekly averages of supplies, arrivals, and temperatures were obtained for the first eight weeks of each season from 1922 to 1927, and seasonal indexes of prices were calculated. Variations in these five factors accounted for 79 per cent of the variations in price.

The average relationship of these factors and watermelon prices is expressed by the equation

$$\log \overline{X} = -0.3558 - 0.00136A - 0.00206B + 0.00939C + 0.00063D - 0.00686G$$

which can be used in estimating future prices ($\overline{X}$) when carlots on track (A), carlot arrivals (B), maximum temperature lagged three days (C), the seasonal indexes (D), and carlot arrivals of important fruits (G) are known or can be closely estimated. Applying this equation over the past six years approximately one-half of the estimated prices come within 15 per cent of the actual prices. Some of the variations of estimated from actual prices are undoubtedly due to the fact that shippers and jobbers cannot estimate the consumer's demand accurately, and hence actual prices may sometimes be above and sometimes below the price which would equate supply and demand. The quality of the watermelons—a factor on which no statistical data are available—variations in truck shipments, and the difficulty of obtaining representative prices probably were the most important remaining factors causing variations of actual from estimated prices.

It seemed logical to expect that cantaloupe arrivals and carlots on track would also affect watermelon prices, but practically no net correlation was found to exist between them. The same thing was true of carlots on track of important fruits, after the effect of the other factors, including carlot arrivals of important fruits, had been taken into consideration.

ACKNOWLEDGMENTS

The writer is indebted to George L. Horenstein, R. H. Heflebower, and F. M. Roush, student assistants, for help in the statistical computations.

LITERATURE CITED

[1] Division of Agr. Econ.
1926 (Dec. 6). Minnesota Agr. Ext. Div. Potato Letter **3**(2):1.

[2] Haas, G. C., and Mordecai Ezekiel.
1926. Factors affecting the price of hogs. U. S. Dept. of Agr. Dept. Bul. **1440**:1–68.

[3] Hedden, W. P.
1926. Studies of market supply, price, and sales as a basis for control of distribution of perishables. Jour. Farm Econ. **8**:213–226.

[4] Killough, Hugh B.
1925. What makes the price of oats. U. S. Dept. of Agr. Dept. Bul. **1351**: 1–39.

[5] Rauchenstein, Emil.
1927. Economic aspects of the apple industry. California Agr. Exp. Sta. Bul. **445**:1–76.

[6] ——— ———
1928. Economic aspects of the watermelon industry. California Agr. Exp. Sta. Bul. **449**:1–26.

[7] Wallace, H. A., and Geo. W. Snedecor.
1925. Correlation and machine calculation. Iowa State College of Agriculture and Mechanic Arts, Official Publication **23**(35):1–47.

[8] Working, Holbrook.
1925. Factors affecting the price of Minnesota potatoes. Minnesota Agr. Exp. Sta. Technical Bul. **29**:1–40.

FACTORS AFFECTING THE PRICE OF GRAVENSTEIN APPLES AT SEBASTOPOL

EMIL RAUCHENSTEIN[1]

THE PROBLEM

Early in 1927 the Gravenstein apple growers in the Sebastopol district organized partly for the purpose of strengthening their bargaining position with buyers in determining the price which they should receive for their apples. This brings up the problem of estimating, at the beginning of the season, the price which will equate supply and demand under the conditions prevailing that season.

While it is generally known that a large crop usually brings a low price per box, and a small crop usually brings a high price, no schedule has been worked out up to this time, on the basis of the average relationship that has prevailed between supply and price, showing the price which crops of various sizes have brought; and no study has been made of the effect on prices of other factors than the supply of Gravensteins in the Sebastopol district. It is the purpose of this paper to present and analyze the data available on this problem in order to determine the important factors that have affected prices in the past, and to show how the results may be used, as a starting point at least, for estimating a fair price at the beginning of the season under a given set of conditions.

DATA AVAILABLE

Records of Gravenstein apple production in the Sebastopol district and prices received by farmers at the packing plants are available from 1912 to date, and are shown in table 1 and figure 1. Table 1 also gives the all-commodity index number for July of each year, which gives a fairly good measure of the changing value of the dollar. By dividing the price for each year by the July index number of that year and multiplying the quotient by 1.50 the adjusted price

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series, shown in column *X*, is obtained. This shows the prices approximately as they would have been if the dollar had had the same purchasing power during the whole period as it had during 1927. The prices referred to hereafter in this paper are these adjusted prices.

The estimates (July 1 and final) of total United States apple production are also shown in table 1 and the July 1 estimates in figure 1.

TABLE 1

APPLE PRODUCTION ESTIMATES OF JULY 1 AND FINAL ESTIMATES FOR THE UNITED STATES, GRAVENSTEIN APPLE PRODUCTION IN THE SEBASTOPOL DISTRICT, AND GRAVENSTEIN APPLE PRICES, 1912–1927

Year	United States production		Gravenstein apple production in Sebastopol district (Thousands of boxes) *B*	Price of Gravensteins per box to farmers at packing plants†	July index‡ numbers (all commodity)	Price adjusted to 1927 price level *X*
	Estimates of July 1 (Millions of bushels) *A*	Final* Estimates (Millions of bushels)				
1912	228	235	53	$0.54	101	$0.80
1913	209	145	42	0.98	102	1.44
1914	210	253	77	0.46	99	0.71
1915	194	230	80	0.52	102	0.77
1916	219	194	96	0.61	125	0.74
1917	200	167	152	0.93	191	0.74
1918	195	170	194	1.43	200	1.06
1919	156	142	322	1.98	216	1.38
1920	200	224	400	1.73	245	1.05
1921	102	99	367	1.72	144	1.79
1922	190	203	714	0.47	158	0.45
1923	189	203	1,172	0.73	153	0.72
1924	196	172	563	1.15	150	1.15
1925	179	172	126	1.96	163	1.80
1926	208	246	1,134	0.39	153	0.39
1927	137	123	680	1.66	147	1.70

Column *A*, data obtained from July numbers of Crops and Markets Monthly Supplement and official series of U. S. Dept. Agr. preceding Crops and Markets.

* From U. S. Dept. Agr. Yearbook **1926**: 896, 1927; except for 1927 which is from Crops and Markets **4** (12): 453. 1927.

Column *B*, data obtained from representative shippers by H. F. Gould and L. W. Fluharty.

† Data obtained by L. W. Fluharty from representative shippers. Average of Fancy 4 and 4½ tier.

‡ Bureau of Labor Statistics index number converted to 1910–1914 base. U. S. Dept. Agr. Supplement to Agriculture Situation June 1927, and current issues.

ANALYSIS OF DATA

General Analysis.—Having eliminated the effect of the changing value of the dollar on prices, it is possible from a close study of figure 1 and table 1 to find some evidence of consistent inverse correlation between production and price (adjusted). Thus from 1912 to 1913 there was a decrease in the July 1 estimate of United States

production associated with a considerable increase in the price of Gravenstein apples. Again there was a decrease in production estimates in each of the years 1917, 1918, and 1919 associated with consistent increases in price. The years 1920, 1921, and 1922 are also good examples of this inverse correlation.

COMPARISON OF GRAVENSTEIN APPLE PRICES WITH PRODUCTION IN SEBASTOPOL DISTRICT AND JULY 1 ESTIMATES OF TOTAL UNITED STATES APPLE PRODUCTION

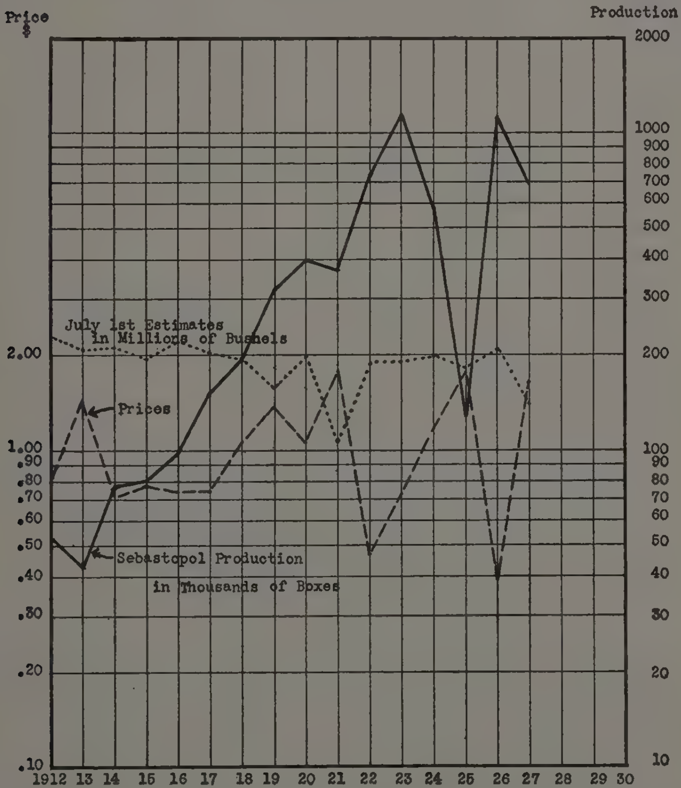

Fig. 1. The inverse correlation between Gravenstein apple production and price in the Sebastopol district is not at all marked until about 1919. Since then it has been noticeable. July 1 estimates of United States production also shows an inverse correlation with Gravenstein prices.

(Data from table 1.)

The inverse correlation between Gravenstein apple production in the Sebastopol district and prices from 1912 to 1918 is not evident, except for the first two years. When one notes the low production of Gravenstein apples—no year above 100,000 boxes during the first five years covered by this study—it becomes evident that they were such a small factor in the market during these years that they would not affect prices to an appreciable extent. The rapid increase in production after 1916 is shown by the fact that although up to that time production was never above 100,000 boxes a year, eight years later (in 1923) the production exceeded 1,000,000 boxes. During several years since 1920, California apple shipments in July which consist mainly of Gravensteins from the Sebastopol district, amounted to one-third of the total United States apple shipments for that month (see table 3).

Beginning with 1919 there is a noticeable inverse correlation between Gravenstein apple production and price. With the exception of 1923 the price changes from the previous years were in the opposite direction from the production. The amount of change in price, however, is apparently affected by both Gravenstein production in the Sebastopol district and United States production. The drop in price from $1.38 to $1.05 from 1919 to 1920 was probably caused only in part by the increase in Gravensteins from 322,000 to 400,000 boxes, and in part by the increase in United States production (July 1 estimates) of 156,000,000 to 200,000,000 bushels. The increase in price in 1921 to $1.79 again was probably due in part to the slight drop in Gravenstein production, but more largely to the big drop (from 200,000,000 to 102,000,000 bushels) in United States production. From 1918 to 1919 Gravenstein production at Sebastopol went up while United States production went down. The latter factor seemed to exert the greater influence since the price of Gravensteins went up.

Correlation Analysis.[2]—The degree of relationship between two variables can be determined with considerable accuracy by means of the correlation coefficient. The final estimates of apple production in the United States from 1919 to 1927 and prices of Gravensteins show a correlation coefficient of — 0.80. However, if growers are to have any basis for estimating the price which Gravenstein apples should bring, data must be used which become available before the

[2] The method used in these calculations is described in detail in the publication by Wallace, H. A., and Geo. W. Snedecor. Correlation and machine calculation. Iowa State College of Agr. and Mechanic Arts, Official Publication 23:1–47. 1925.

crop is sold. Since the crop is usually shipped during July and the first part of August, the July 1 estimate of total apple production should give the best indication of the probable effect of production in the country as a whole.

The estimates of July 1 were not as close to the final production during the first years of the period as they were later, although even from 1914 to 1927 the correlation coefficient between them and Gravenstein prices is -0.77.

A study of the other factor (production of Gravensteins in the Sebastopol district) clearly shows some association with prices during recent years. Some difficulties are involved, however, in evaluating its effect for the whole period, because of the rapid increase in production from less than 100,000 boxes in 1912 to more than 1,000,000 boxes in 1923 and 1926. Disregarding trend in production the correlation coefficient between Gravenstein apple production in the Sebastopol district and price was -0.2602 for the period 1912 to 1927, and -0.2616 for the period 1914 to 1927. Obviously these correlation coefficients do not show the true relationship for the later years because of the irregular upward trend in production, and further the effect has probably been increasing relative to the effect of total United States production.[3]

A multiple regression equation based on the period 1914 to 1927 for estimating prices from July 1 estimates of United States production and Gravenstein production in the Sebastopol district would probably overemphasize the effect of the latter.

In order to compare possible changes in the regression equation for various periods the necessary calculations were made based on the relationships between the three factors for the period 1914–1927. The resulting equation was $\overline{X} = 3.3741 - 0.01179A - 0.000402B$, in which $\overline{X}$ represents estimated price in dollars, A, July 1 estimates of United States production, and B, Gravenstein production in the Sebastopol district. The multiple correlation coefficient ($R_{X.AB}$) was equal to 0.8298, the standard error of estimate ($S_{X.AB}$) was 0.256, and the coefficients of determination indicated that approximately 61 per cent of the variations in price were due to United States production and 8 per cent to Sebastopol production of Gravensteins. Price estimates for the period 1914–1927 based on the above equation fall within $0.25 of the actual price ten out of the fourteen years.

[3] By correlating first differences of logarithms of production and prices a correlation index of -0.54 is obtained. This method does away with the difficulty of the production trend, but cannot show whether or not the relationship is becoming closer toward the end of the period.

Correlation of Production and Price from 1919 to 1927.—Figure 1 shows that Gravenstein apple production in the Sebastopol district increased very rapidly from 1913 to 1919. Since 1919 the trend upward has been much less pronounced and in one year (1925) the production was below that of 1919. An analysis of the average relationships that have prevailed between production and price during the later period therefore should give results more applicable to the problem of estimating the price that will move the 1928 and 1929 crops, than the results based on the average relationship for the whole period 1912 to 1927, in spite of the fact that only nine years are included in the later period. The correlations for the later period are in line with what one would logically expect. That is, since 1919 the Sebastopol crop of Gravensteins has become a more important factor on the markets in July and August than it was previous to 1919, and therefore its effect on Gravenstein apple prices during the later period has been much more marked than it was for the earlier period. This is brought out by the coefficients of determination, which indicate that for the period 1919 to 1927, 40.7 per cent of the variations from year to year in Gravenstein apple prices were associated with variations in production of Gravensteins in the Sebastopol district, compared with 8.0 per cent for the period 1914 to 1927; and 38.5 per cent were associated with variations in the July 1 estimates of total United States production in the later part of the period, compared with 61.0 per cent for the whole period.

Table 2 and figure 2 show the actual and estimated prices of Gravenstein apples. The estimated prices are based on the average relationship of actual prices and the production data noted above for the period 1919 to 1927. This period, of course, is too short to constitute a very reliable statistical sample, but the results bear out the logical expectations.

The residuals (actual prices minus estimated) in table 2 are \$0.17 or less in six years out of the nine. The extremely low price of 1922 may have been caused in part by the railroad strike at the time Gravensteins were being shipped.[4] In 1925 the actual price was \$0.29 above the estimated price. Apparently the extremely short crop (126,000 boxes) in the Sebastopol district exerted more than a proportional upward pull on the price. In 1927 the actual price again exceeded the estimated, this time by \$0.30. Possibly the organization of growers in 1927 which quoted a uniform price to buyers may have strengthened their bargaining power to the extent of \$0.30 a box.

[4] This suggestion was made by Mr. G. E. Burlingame, secretary of the Sebastopol Chamber of Commerce.

TABLE 2

ACTUAL AND ESTIMATED PRICES OF GRAVENSTEIN APPLES, 1919–1927

Year	Actual adjusted price X	Estimated price $\overline{X}$	Residuals Z
1919	$1.38	$1.54	$−0.16
1920	1.05	1.11	−0.06
1921	1.79	1.95	−0.16
1922	0.45	0.93	−0.48
1923	0.72	0.55	+0.17
1924	1.15	1.01	+0.14
1925	1.80	1.51	+0.29
1926	0.39	0.43	−0.04
1927	1.70	1.40	+0.30

Column $\overline{X}$ calculated from the equation $\overline{X}=3.10901-0.00832\ A-0.000839B$.
Residuals Z equal actual minus estimated prices.

ACTUAL AND ESTIMATED FARM PRICES OF GRAVENSTEIN APPLES

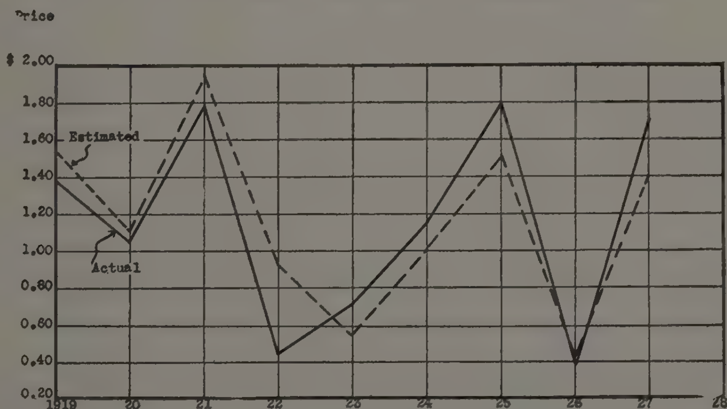

Fig. 2. Estimates of Gravenstein apple prices based on the average relationship between prices, July 1 estimates of United States production, and Gravenstein production in the Sebastopol district come within $0.17 of the actual price six years out of nine.

(Data from table 2.)

Possible Causal Relationships Involved in the Determination of Gravenstein Apple Prices.—The fact that there is a high degree of association between two variables does not prove that one is necessarily the antecedent or cause of the other. In the case of Gravenstein apple production in the Sebastopol district and prices of Gravensteins at Sebastopol, it seems clear that high production would cause low prices (other things remaining the same) and low production

would cause high prices. The correlation coefficient between these two variables from 1919 to 1927 was —0.749, which may be considered as representing a cause and effect relationship. With July 1 estimates of total United States production and Gravenstein apple prices, the cause and effect relationship is not so self evident. Are buyers influenced by the supply coming onto the markets in July and early August, or by their anticipation of the size of the total crop? Probably both factors affect the price. Table 3 and figure 3

TABLE 3

TOTAL APPLE SHIPMENTS IN THE UNITED STATES AND FROM CALIFORNIA FOR JULY AND AUGUST, AND FARM PRICES OF GRAVENSTEIN APPLES AT SEBASTOPOL, 1919–1927

Year	July shipments		August shipments		Prices (adjusted) to farmers at Sebastopol
	Total United States carlots	California carlots	Total United States carlots	California carlots	
1919	1,347	273	2,712	441	$1.38
1920	1,855	244	3,861	723	1.05
1921	1,207	352	3,384	690	1.79
1922	2,592	220	4,923	998	0.45
1923	3,360	1,290	4,122	984	0.72
1924	2,362	729	3,126	645	1.15
1925	2,895	341	4,330	155	1.80
1926	3,665	1,480	3,131	591	0.39
1927	1,731	289	3,352	841	1.70

Prices from Table 1.

Shipments for 1919–1922 compiled from U. S. Dept. Agr. Statis. Bul. 7:2–5; for 1923–1926 from Monthly Supplement of Crops and Markets 3 (8, 9) 1926; for 1927 from Monthly Supplement of Crops and Markets 4 (8, 9), 1927.

show apple shipments in July and August in the United States, California apple shipments in July, and the price of Gravensteins at Sebastopol. In general, low July shipments were associated with high prices, and high shipments with low prices. The year 1923 seems to be an exception since the price and shipment changes from 1922 are both upward. This may be due to the railroad strike in 1922 (mentioned on p. 330) which seems to have depressed the 1922 price much below normal for the production of that year. Compared with other years than 1922, the price in 1923 seems to be normal considering the quantity shipped. The year 1925 is noteworthy in that price and shipments were both higher than in 1924. Gravenstein prices in 1925 seem to have been affected specifically by the short crop of Gravensteins since shipments for the United States as a whole were relatively high, but shipments from California were very low. The

correlation coefficient between July shipments in the United States and Gravenstein prices for the period 1919 to 1927 was — 0.65, between California apple shipments in July and Gravenstein prices — 0.58, and between July 1 estimates of United States production and Gravenstein prices it was — 0.74.

APPLE SHIPMENTS IN THE UNITED STATES AND CALIFORNIA AND PRICES OF GRAVENSTEIN APPLES

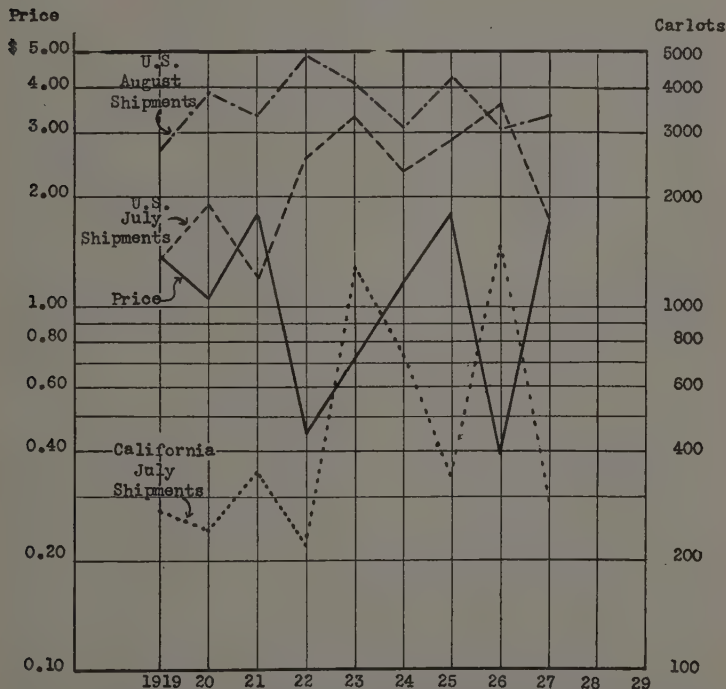

Fig. 3. High apple shipments in the United States in July and low prices for Gravensteins tend to go together and low shipments go with high prices. Since 1923 California shipments in July and Gravenstein prices show a close inverse correlation.

(Data from table 3.)

August shipments in the United States are not as closely correlated with Gravenstein apple prices as are the July shipments. The correlation coefficient is — 0.3819. This smaller correlation is to be expected because the bulk of the Gravenstein apple crop is usually marketed in July.

There is a fairly close correlation between July shipments in the United States from 1919 to 1927 and July 1 estimates of United States production. The correlation coefficient is — 0.73. The correlation coefficient between July shipments and final estimates of production is also — 0.73. Probably one reason why the correlation between July apple shipments in the United States and Gravenstein apple prices is not closer than the correlation of July 1 estimates of United States production and prices is that July shipments vary from year to year, partly as the result of variations in the size of the total crop, and partly as the result of the time of ripening. If accurate data could be obtained as to the total quantities of apples coming onto the markets during the period in which Gravenstein apples are marketed, they would probably show a higher correlation coefficient with price than that obtained between July 1 estimates and price.

The practical conclusion to be drawn from these correlation studies is that the July 1 estimates of United States production are the best figures to use in estimating the effect of the country's total apple production on the price of Gravenstein apples because they probably indicate fairly accurately the competition which Gravenstein apples will have during the following six or eight weeks with apples from other parts of the United States.

HOW TO USE THE RESULTS OF THE PRICE ANALYSIS

The average relationship between July 1 estimates of United States apple production (A), Gravenstein apple production in the Sebastopol district (B), and the price of Gravensteins (X), for the period 1919 to 1927, is expressed in the formula

$$\overline{X} = 3.10901 - 0.00832A - 0.000839B,$$

in which A is in millions of bushels, B in thousands of boxes, and $\overline{X}$ in dollars per box. This equation indicates that for the period 1919 to 1927 each change of 1,000,000 in A, the price on an average changed 0.832 cents, and for each change of 1,000 in B the price changed 0.0839 cents—changes in price in each case being in the opposite direction from changes in quantities.

The fact that the relationship expressed by this equation has held somewhat consistently for the past nine years should make it of some value to buyers and sellers of Gravenstein apples in California in deciding on a price for apples which should move them into consumption.

AVERAGE RELATIONSHIP OF PRODUCTION AND PRICE, 1919–1927

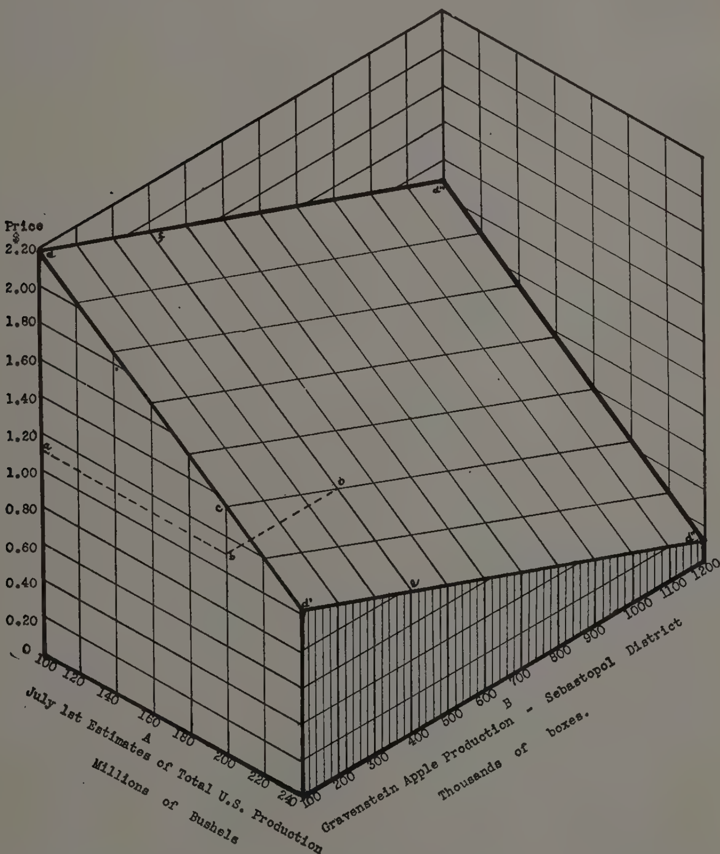

Fig. 4.—The line dd' and those parallel to it show the average net effect of July 1 estimates of United States production on Gravenstein apple prices with Gravenstein production held constant at various values along B. The line dd''' and those lines parallel to it show the average net effect of Gravenstein apple production in the Sebastopol district on price with United States production held constant at various values along A.

To illustrate the use of the equation let us assume the following conditions:

A—July 1 estimates of United States apple production = 200 million bushels.

B—Sebastopol production of Gravenstein apples = 400 thousand boxes. (Estimates of the size of the crop in the Sebastopol district can be made very accurately at the beginning of the season.)

The problem is to find $\overline{X}$—the price to the farmers which, based on past experience, will come closest to equating supply and demand.

Substituting in the equation

$$\overline{X} = 3.10901 - 0.00832A - 0.000839B$$

the above values for *A* and *B* we obtain

$$\begin{aligned}\overline{X} &= 3.10901 - (0.00832 \times 200) - (0.000839 \times 400)\\ &= 3.10901 - 1.664 - 0.3356\\ &= \$1.11\end{aligned}$$

The estimated price for any values of *A* and *B* within the range shown may also be obtained approximately from figure 4, which shows graphically the average effect of *A* and *B* on price from 1919 to 1927. The line *dd′* in figure 4 shows the average net effect on price of production estimates from 100 million to 240 million bushels with a constant production of 100 thousand boxes for *B*. The next line parallel to *dd′* shows the average net effect on price of production estimates from 100 million to 240 million bushels with a constant production of 200 thousand boxes for *B*. The other lines parallel to *dd′* including *d‴d″* show the net effect on price of production estimates from 100 to 240 million bushels with constant productions of 300, 400, 500, etc., to 1,200 thousand boxes at *d‴d″*.

In the same way the line *dd‴* shows the average net effect of varying *B* from 100 thousand to 1,200 thousand while *A* is constant at 100 millon. The next line parallel to *dd‴* shows the same thing for various values of *B* with *A* at 120 millions. The other lines parallel to *dd‴* including *d′d″* show the net effect on price of various values of *B* with *A* at values from 140 to 240 million bushels.

To illustrate the use of figure 4 in estimating the price that will equate supply and demand let us assume a value of 200 million for *A* and 400 thousand for *B*—the same values used in illustrating the use of the equation above. The line extending from 200 on the base line *A* to the line *dd′* meets it at *c*, which indicates a price estimate of $1.36 with *B* having a value of 100 thousand. In order

to get the price estimate when B has a value of 400 thousand, follow the line from c to o parallel to $d'd''$. At o it intersects the line ef which gives the various price estimates when B equals 400 thousand and A varies from 100 million to 240 million. The point o, therefore, is the point which represents the price estimates when A equals 200 million and B 400 thousand. In order to read the price represented by o, draw a line from o parallel to B until it meets the vertical line extending from 200 to c. This intersection occurs at b. From b extend a line parallel to A which meets the price scale at a where the reading is $1.11.

TABLE 4

AVERAGE RELATION OF JULY 1 ESTIMATES OF UNITED STATES PRODUCTION, GRAVENSTEIN PRODUCTION, AND PRICES OF GRAVENSTEINS FROM 1919–1927

July 1 estimates of United States production millions of bushels	Gravenstein production thousands of boxes							
	100	200	300	400	500	600	700	800
	Prices of Gravensteins,* dollars							
100	2.19	2.11	2.03	1.94	1.86	1.77	1.69	1.61
120	2.03	1.94	1.86	1.78	1.69	1.61	1.52	1.44
140	1.86	1.78	1.69	1.61	1.51	1.44	1.36	1.27
160	1.69	1.61	1.53	1.44	1.36	1.27	1.19	1.11
180	1.53	1.44	1.36	1.28	1.19	1.11	1.02	0.94
200	1.36	1.28	1.19	1.11	1.03	0.94	0.86	0.77
220	1.19	1.11	1.03	0.94	0.86	0.78	0.69	0.61
240	1.03	0.94	0.86	0.78	0.69	0.61	0.52	0.44

* Based on the regression equation $\overline{X}=3.10901-0.00832A-0.000839B$.

The price estimates that will be obtained at the intersection of the various lines on the plane $d\ d'\ d''\ d'''$ of figure 4 are shown in table 4. Thus when A equals 200 and B equals 400 the price estimate $1.11 is found at the intersection of the line of price estimates having 200 on the left and the column of price estimates having 400 above. It is interesting to note that a change of 20 in A has approximately the same effect on the estimated price as a change of 200 in B. For example, values of 100 for A and 300 for B give the same estimated price of $2.03 as values of 120 for A and 100 for B. This, of course, is also apparent from the equation $\overline{X} = 3.10901 - 0.00832A - 0.000839B$. For intermediate values of A and B, such as 185 for A and 740 for B, close estimates can be made from either figure 4 or table 4.

SUMMARY

The price of Gravenstein apples at Sebastopol is affected by the size of the Gravenstein crop in that district, and by the size of the total apple crop in the United States. The relative effect of the former has been increasing with the increase in the size of the crop since 1912, and the effect of the latter has been decreasing.

The extent of the competition which Sebastopol Gravenstein apples are likely to meet from the rest of the United States is indicated to some extent at the beginning of the season by the July 1 estimates of United States production which are closely correlated with July shipments of apples. From 1919 to 1927 approximately 38.5 per cent of the variations in Gravenstein prices are accounted for by variations in July 1 estimates of United States production, and 40.7 per cent of the price variations are accounted for by variations in Gravenstein production in the Sebastopol district.

The average relationship from 1919 to 1927, between price and the important factors that have been found to affect price, is shown by the equation

$$\overline{X} = 3.10901 - 0.00832A - 0.000839B$$

in which $\overline{X}$ represents estimated price, A represents July 1 estimates of United States apple production in millions of bushels, and B represents Gravenstein apple production in the Sebastopol District in thousands of boxes. Table 4, page 337, has been prepared by substituting the various production figures in the above equation and solving for $\overline{X}$—the price, judging from past experience, that is most likely to equate supply and demand for each combination of production figures. An understaning of the relationships that have prevailed in the past should be of value to any organization of Gravenstein apple growers in the Sebastopol district that wishes to have some basis for estimating at the beginning of the season, the price which is likely to bring about this equilibrium between supply and demand.

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